Development & Evaluation of Tulsi (*Ocimum sanctum*) Based Herbal Edible Coatings

A Synopsis

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I. INTRODUCTION

The issue of postharvest losses is of high and global importance in the efforts to combat hunger, raise income and improve food security in countries of the world (Phan, 2008). This is mostly due to advantages such as freshness, low caloric content, and the ability to promote fruits and vegetables as basic components of a healthy diet(Raybaudi-Massilia*et al.*, 2007).

A. Edible coatings

Edible films or coatings are flexible materials used in food coating and packaging for food extend storage period. Earlier studies have shown that films can extend the shelf life of foods through the inhibition of the migration of moisture, oxygen, carbon dioxide and aroma (Kokoszka*et al*., 2007). Edible films and coatings are an environment friendly technology that, to some extent, may replace plastic packaging by natural and biodegradable substances (Chamorro, 2009).

- **Classification of edible coating**

Edible coatings and films are natural polymers obtained from products or by-products of agricultural origin, such as animal and vegetable proteins, gums, lipids, and celluloses. Generally, its thickness is less than 0.3 mm (Pavlath*et al*., 2009). According to Han and Gennadios (2005), Edible coatings are divided into three classes-Hydrocolloids, Lipids and Composites.

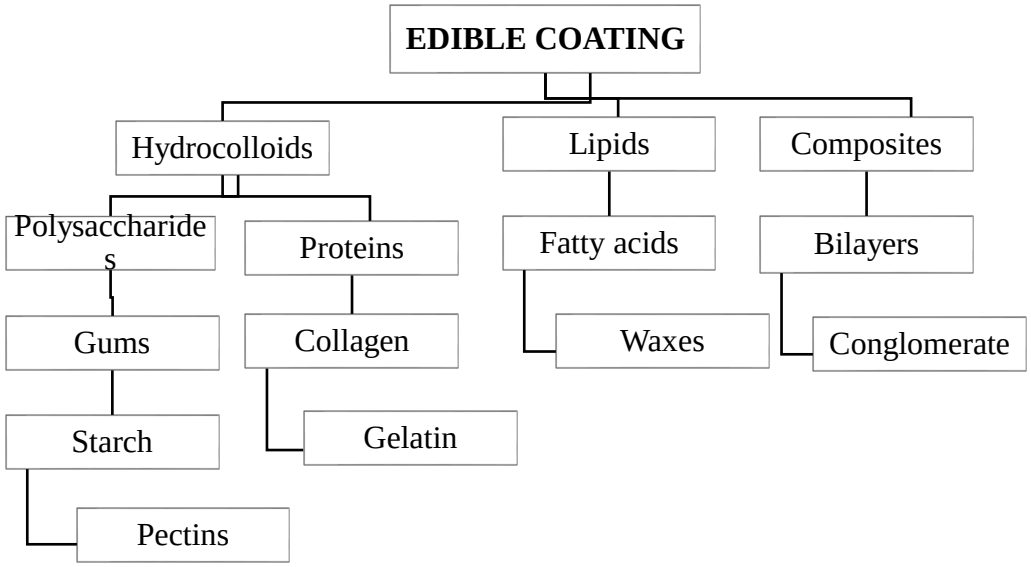

Figure 1: Different types of edible coatings, Source- Han and Gennadios, (2005).

***Chitosan:* -** Chitosan is commercially produced from deacetylated chitin found in shrimp and crab shell. Chitosan is a linear copolymer composed of β (1→4)-linked, 2-acetamido-2-

deoxy-β-d-glucopyranose and 2-amino-2-deoxy-β-glucopyranose units. It is a biocompatible, biodegradable and antimicrobial polymer. Chitosan has functional properties that make it useful in nutrition (Gallaher *et al.*, 2002).

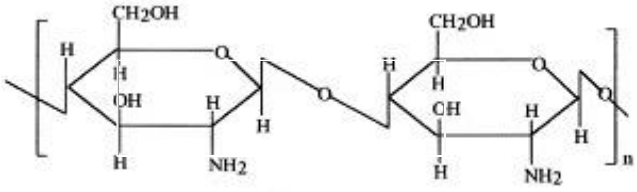

Figure 2: Structures of chitin and chitosan, source: Kumar*et al*., (2000).

***Alginate*:-** Alginates are the salts from alginic acid, an acidic polysaccharide that functions as a structural component in brown seaweeds (Phaeophyceae). Commercial alginate is extracted from algae species. Alginic acid is composed of (1, 4)-β-D-mannuronic acid (M) and α-L-guluronic acid (G) residues (King 1983; Draget 2009). Alginates have been applied in the food industry as stabilizers, thickeners, films or edible coating and gels (Draget, 2009).

β-D-mannuronate (M) **α-L-guluronate (G)**

Figure 3: Alginate monomers, Source: Draget, (2009).

***Beeswax*: -** Beeswax (white wax) is produced from honeybees and secreted by their glands below its abdomen (Plotto and Baker, 2005). Wax is collected from the combs of bee colonies by melting the comb in boiling water, filtering and casting into cakes. Beeswax is already approved by IFOAM (Plotto and Baker, 2005). Waxes are used as barrier films to gas and moisture on fresh fruits and vegetables.

- **Herbal edible coating**–

Herbal edible coating is a new technique for food industry. It is made from herbs or combination of other edible coatings and herbs, most common herbs used in edible coatings are such as *Aloe vera* gel, Neem, Lemon grass, Rosemary, Tulsi, and Turmeric. Herbs have antimicrobial properties, it consists vitamins, antioxidants and essential minerals (Douglas *et al*., 2005; Kavas *et al*., 2015; Kumar and Bhatnagar, 2014).

Tulsi (Ocimum sanctum)

Tulsiis a miraculous medicinal plant. It is a member of the *Ocimum* genus. The botanical name of Tulsi is "*Ocimum sanctum*" and also known as "*Ocimum tenuiflorum"*. It is a tropical plant which grows as weed and also cultivated. There are three main types of Tulsi

(Krishna tulsi, Rama tulsi and Vana tulsi). The English name of tulsi is 'Holy Basil' (Douglous*et al*., 2005).

Botanical Classification:-

Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Magnoliopsida
Order:	Lamiales
Family:	Lamiaceae
Genus:	*Ocimum*
Spices:	*tenuiflorum or sanctum.*
B. Name:	*Ocimum sanctum*

Figure 4: Tulsi classification and Plant, Source: www.naturalhealthcure.org.

Constituents

The whole Tulsi plant is a rich source of phytochemicals which possess strong antioxidant, adaptogenic, antibacterial, antiviral, and immune resistance properties that enhance the general health and support the body to fight against disease causing germs (antigens). The main constituents are Eugenol, B-caryophyllene, sesquiterpenes, monoterpenes, ascorbic acid (vitamin C), carotene (vitamin A), calcium, iron and selenium as well as zinc, manganese, and sodium as trace elements. This constituent is FDA approved food additive which is naturally present in Tulsi (Douglous *et al.*, 2005). It have excellent medicinal properties which are helpful for treatment of diseases like common malariadengue, headaches, stomach ache, cold and inflammation and skin problems.

B. FRESH FRUITS AND VEGETABLES USED IN EDIBLE COATING

Fruits and vegetables are essential for a healthy and balanced diet. The five fruits and vegetables will be taken for application of edible coatings. These fruits and vegetables are strawberry, cucumber, apple, capsicum and pear.The fruits are good source vitamins, minerals, flavonoids, carbohydrates, proteins, fibres and antioxidants.

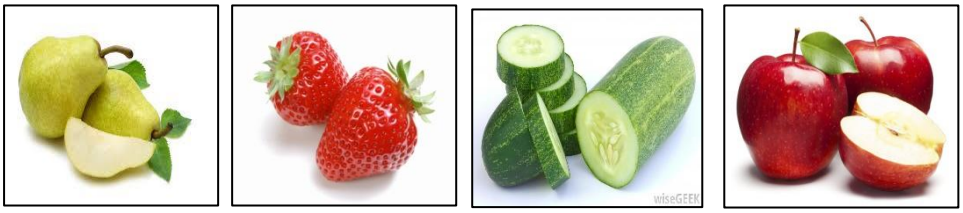

Figure 5: Fruits and vegetables, Source: www.newworldencyclopedia.org

Botanical classification of fruits and vegetables:

Classification	**Strawberry**	**Cucumber**	**Apple**	**Pear**
Kingdom:	Plantae	Plantae	Plantae	Plantae
Division:	Magnoliophyta	Magnoliophyta	Magnoliophyta	Magnoliophyta
Class:	Magnoliopsida	Magnoliopsida	Magnoliopsida	Magnoliopsida
Order:	Rosales	Cucurbitales	Rosales	Rosales
Family:	Rosaceae	Cucurbitaceae	Rosaceae	Rosaceae
Genus:	*Fragaria*	*Cucumber*	*Malus*	*Pyrus*
Spices:	*Ananasa*	*Sativus*	*Domestica*	*communis*
B. Name:	*F. ananasa*	*C. sativus*	*M. domestica*	*P. communis*

Figure 6: Botanical classification of fruits and vegetables,
Source: www.newworldencyclopedia.org

Benefits of Fruits and vegetables: - According to WHO (1991) Consumption of fruits and vegetables as per the recommended level has many potential health benefits. Fruits and vegetables (strawberry, apple, capsicum, pear, cucumber etc.) are good dietary source of minerals and vitamins. The minerals are found in fruits and vegetables potassium, phosphorus, calcium, magnesium, sodium, iron, manganese, zinc, copper, and selenium and these are also a good source of the vitamins: Vitamin C, thiamine, riboflavin, niacin,and pantothenic acid, Vitamin B6, Folate, Vitamin B12, Vitamin A, and Vitamin E (Liu, 2003). The nutrient health benefits of fruits and vegetables have been proven epidemiologically. They are not only necessary for providing essential nutrients to the body but also contain bioactive compounds which help in preventing many diseases (Liu, 2003).

I. OBJECTIVES

1. To develop and evaluate the effect of various herbal edible coatings to enhance shelf life of fresh fruits and vegetables.
2. To study the effect of herbal edible coatings on dehydration properties of fruits and vegetables.
3. To study the effect of different packaging materials on the quality of herbal edible coated fruits and vegetables.

II. REVIEW OF LITERATURE

Abbasi *et al.* (2009) analysed the effect of coating with irradiated Crab and Shrimp chitosan (CHI irr.Mv = 5.14 × 104) and un-irradiated Crab chitosan (CHI unirr. Mv = 2.61 × 105) on postharvest preservation of mango (*Mangifera indica* L.) fruit. Irradiation at 100 kGy and 200 kGy of both Crab chitosan and Shrimp chitosan were used and the fruits were stored at 15°C ± 1°C and 85% relative humidity for 6 weeks. The effect of various chitosan coatings on fruit ripening behaviour, biochemical and organoleptic characteristics were evaluated during storage. The incidence of disease attack was also observed. The overall results showed the superiority of irradiated Crab chitosan (200 kGy) in extending the shelf-life of mango fruit as compared to control. The irradiated Crab chitosan (200 kGy) treated fruits also maintained their eating quality up to 4 weeks of storage. Only 6% disease incidence was observed in irradiated crab chitosan coated fruits.

El-Annay *et al.* (2009) evaluated the effect of soybean gum, jojoba wax, glycerol and Arabic gum as edible coatings instead of paraffin oil on the shelf life and quality of Anna Apple during cold storage at 0˚C and 90-95% RH. The results indicated that coated Apple showed a significant delay in the change of weight loss, firmness, Titratable acidity, total soluble solids, decay and colour compared to uncoated ones. Sensory evaluation results showed that coatings maintain the visual quality of the Anna Apple during the storage time. The results suggested using soybean gum, jojoba wax, glycerol and Arabic gum as edible coating instead of paraffin oil.

Moayednia *et al.* (2010) investigated an alginate-based edible coating affected on the preservation and quality of strawberries during cold storage (5 °C). Sodium alginate and calcium alginate coating material used for surface coating on Strawberry. The quality of coated and non-coated strawberries was evaluated by physiochemical characteristics over a 14-day storage period. Results showed that coating with calcium alginate had no significant effects on weight loss or physicochemical parameters when compared to control fruit, but it did result in the postponement of visible decay during refrigerated storage.

Ergun and Satici (2012) studied the effects of *Aloe vera* gel (0, 1, 5 and 10% w/v) coating on green-coloured ‘Granny Smith’ and red-coloured ‘Red Chief’ apples those were stored at 2 °C for 6 months. Soluble solids content and percentage titratable acidity was recorded higher for ‘Granny Smith’ apple fruit treated with *Aloe vera* gel (5 and 10%) during most of the storage period while no *Aloe vera* gel effects on colour for ‘Red Chief’ apples was recorded. The pH values for ‘Granny Smith’ fruit slightly decreased while slightly increased for ‘Red Chief’ fruit over time, yet values for both cultivars remained unaffected

by *Aloe vera* gel treatments. The results indicated that *Aloe vera* gel treatment may be used as bio-preservative on 'Granny Smith' apples for retarding quality losses.

Athmaselvi *et al.* (2013) investigatedthe effect of formulated *Aloe vera* based edible coating on mass loss, colour, firmness, pH, acidity, total soluble solid, ascorbic acid and lycopene on the coated tomato. The tomato in control showed a rapid deterioration with an estimated shelf life period of 19 days, based on the mass loss, colour changes, accelerated softening and ripening. On the contrary, the coating on tomatoes delayed the ripening and extended the shelf life up to 39 days. From the results, it was concluded that the use of *Aloe vera* based edible coating leads to increased tomato shelf-life.

Soomro *et al.* (2013) investigated the storage life of 'langra' mangoes, fruits coated with sunflower wax. Sunflower wax coating protects the mangoes in greater proportion to change their physiochemical factors. Application of sunflower wax coatings had no effect on vitamin 'C' content of mangoes variety and could increases mango storage time around 30 days under regular storage conditions. Sunflower wax coating also inhibited the growth of micro-organisms. The data reveal that by applying a sunflower wax coating effectively prolongs the quality which attributes and extends the shelf life of mango.

Yulianingsih *et al.* (2013) developed an edible coating from *Aloe vera* and tested on minimally processed cantaloupe fruit for the extension of shelf-life. A coating from *Aloe vera* with 0.02% ascorbic acid, 1% Glycerol and 1.5% CMC (Carboxymethyl Cellulose) was applied on minimally processed cantaloupe. Cantaloupes coated with the *Aloe vera* were stored at 5, 10, 15, 20 and 27°C for 24, 48, 76 and 96 hours. The applications of coating from *Aloe vera* on cantaloupe were shown reducing physical changes and effective in retaining the firmness of the minimally processed cantaloupe.

Chauhan *et al.* (2014) analysedthe effects of biodegradable *Aloe vera* gel (0, 1, 5 and 10% w/v) coating on green grape berries, stored at 15 °C for 40 days in air tight container. Treated berries (5 % and 10 %) showed minimum physiochemical activities and reduced bacterial and fungal count, which significantly increased in uncoated berries over storage and flavourrelated factors such as TSS and TTA levels were observed maximum in treated grape berries (5 % and 10 %) and sensory analyses of treated berries revealed beneficial effects in terms of delaying rachis browning and maintenance of the visual aspect of the berry without any detrimental effect on organoleptic characteristics. This work evaluates the use of *Aloe vera* as bio-preservative, which is an economical and eco-friendly**.**

Chauhan *et al.* (2014) evaluated the efficacy of chitosan, calcium chloride separately and in the combination (hurdle technology) as an effective preservative for the

increment of the shelf life of mango (*Mangifera indica*) during storage. Treated fruits and controls were stored at 15± 1 °C and 85% RH with chitosan and calcium chloride separately and 60 days shelf life was recorded. But 65 days shelf life period was noticed when treated with chitosan and calcium chloride in combination i.e. with hurdle technology. Better results were noticed when mango samples were applied with hurdle technology in combination of chitosan and calcium chloride.

Chauhan *et al.* (2014) studied the application of plant natural extracts for extending storage period of apple *(Malus domestica*). Apple surface were coated with 1%, 1.5%, 2% neem oil, *Aloe vera* and 10% 15%, 20% extracts of marigold flower (*Tagetes erectus*). Then analysed for physiological and physiochemical and microbial analysis.TSS and TTA levels were observed maximum in treated Apples.Sensory analysis of treated apples showed beneficial effects of the apple. This work evaluated the use of neem oil, *Tagetes erectus*, *Aloe vera* as edible coating, which is an economical and eco-friendly. The results show that *A. vera* gel, neem oil and marigold extracts could be applied for storage of apple fruit as these natural coatings inhibit microbial spoilage and reduce decay incidence during postharvest storage of apple and stored at 15˚C for 45 days.

Nasution *et al.* (2015) investigated the effect of additives in *Aloe vera* (AV) gel coating on fresh-cut guava stored at 5 °C and 75–80% relative humidity. Eight treatments were employed involving three additives and their combinations. A control sample coated only with AV gel and a comparison sample of uncoated fresh-cut guava were also prepared. The additives used were 1.5% ascorbic acid, 2% calcium chloride, and 0.2% potassium sorbate. Additives helped to extend the shelf life of the coated samples, with PS and AA giving the highest inhibition effects. AV + $CaCl_2$-coated guava showed the lowest weight loss (3.57 ± 0.39%) whilst maintaining sufficient hardness.

Ghosh *et al.* (2015) studied the corn starch coating of different concentration (1%, 2%, 3%, 4%, 5% and 6%) used to study the storage life and post-harvest quality of Assam lemon fruits. The effect of this coating in fruits on total soluble solid, Titrable acidity, ascorbic acid, total sugar, reducing sugar, juice content and physiological loss in weight, length, breadth and colour was assessed during storage. Among various treatments, coating with 4% corn starch was found very effective in maintaining higher TSS, acidity, ascorbic acid, total sugar, reducing sugar, juice content, length, breadth and lower physiological loss in weight compared to control. This treatment retained natural light-green colour up to 12 days of storage.

III. MATERIAL & METHODS:

The methodology will be divided into seven stages, these are follows-

1. Collection of raw materials
2. Development of herbal edible coatings
3. Application of developed edible coatings on fruits and vegetables
4. Evaluation of various parameters of coated fruits and vegetables
5. Study of coated fruits and vegetables at storage temperature
6. Evaluation of Packaged coated fruits and vegetables
7. Statistical analysis

1. Collection of raw material:-

- ***Plant material*****: -** FreshTulsi leaves (*Ocimum sanctum*) will be collected from University campus.
- ***Fruit and vegetable materials:*** - Fresh strawberry, cucumber, pears and Apple will be purchased from local market.
- ***Coating materials*****:** Chitosan, alginate, corn starch and beeswax will be purchased.

2. Development of herbal edible coatings: -

- ***Extraction of Tulsi leaves:*** - Fresh Tulsi (*Ocimum sanctum*) leaves extract will be prepared by the method of Singh *et al.,* (2013).
- ***Chitosan solution: -*** Chitosan solution will be prepared by method of Agullo *et al*. (2003) and Shiri *et al.,* (2013).
- ***Alginate solution*****: -** Alginate edible coating solution will be prepared according to Ghavidal *et al.,* (2014).
- ***Corn starch solution*****: -** Corn starch coating solution will be prepared by using the method in Ghosh *et al.,* (2014).
- ***Beeswax solution*****: -** Beeswax edible coating will be prepared according to Ruzaina *et al.* (2013).
- ***Addition of Tulsi extract:*** **-** The three percentage of tulsi extract will be added in above edible coating solutions.

3. Application of developed edible coatings on fruits and vegetables*:* - Edible coatings will be applied on fruits vegetables by three methods-

- Dipping method
- Brushing method
- Spraying method

4. Evaluation ofvarious parameters of coated fruits and vegetables:

- Physio-chemical parameters
- Sensory analysis
- ***Physio-chemical parameters:*** The physio-chemical parameters are as follows -

- Appearance change: Appearance changes will be analysed by visual and photographically recorded. All photographs will be taken at the same angle and distance.
- Weight loss: The difference between initial and final weight will beconsidered as a total weight loss during that storage interval and calculated as percentages on a fresh weight basis according to the standard method (AOAC, 1994).
- Firmness /Texture: The firmness of coated and control samples will be analysed using a penetrometer/texture analyser (Ranganna, 2003).
- Decay percentage: The number of decayed fruits was counted on zeroth day and final day and the decay rate percentage was calculated (ASTM, 1983).
- Total soluble solids: In order to determine the TSS of fruits and vegetables, a digital refractometer with a scale of 0 to 32 ˚Brix will be used (Ranganna, 2003).
- pH: p^H will be determined by using the method of Ranganna (2003).
- Titratable acidity: Titratable acidity will be determined by using the method of Ranganna, (2003).
- Ascorbic acid content: DCPIP (2,6-dichlorophenol-indophenol) visual titration method, described by Ranganna, (2001) will be used to determine the ascorbic acid content or Vitamin C determination of coated and uncoated samples will be carried out following the AOAC, (1994) method.
- Total phenolic content: Total phenolic content (TPC) will be determined by using the Folin–Ciocalteu method as described by Singleton *et al.* (1999).
- Dehydration studies of coated fruits and vegetables***: -***

- *Organoleptic parameters*: - The organoleptic parameters such as colour, texture, aroma, and flavour will be analysed of dehydrated herbal edible coated fruits and vegetables by visual inspection.
- *Reconstitution properties****:*** **-** Reconstitution properties of dehydrated coated fruits and vegetables will be evaluated according to Al-Amin *et al.*, (2015).
- ***Sensory Analysis:*** **-** Samples will be evaluated for overall sensory acceptability based on fruit shape, appearance, colour and flavour by a panel of 15 judges at the different storage interval using 9 Point Hedonic Scale (Larmond,1977).

5. **Study of coated fruits and vegetables at storage condition:** -The coated fruits and vegetables will be studied at ambient temperature (25-30˚C) and refrigeration temperature (4˚C) analysed by visual inspection (ASTM, 1983).
6. **Evaluation of packaged coated fruits and vegetables*:* -** The coated fruits and vegetables will be packaged from different packaging material and then quality parameters will be analysed which influence the quality and shelf life of coated fruits and vegetables.

- HDPE
- LDPE
- Brown paper bags
- Cloth bags
- Jute bags.

7. ***Statistical analysis*:** All the data of different attributes under different treatments will be subjected to analysis of variance (ANOVA) with storage time and treatment as sources of variation.

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